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INTERNATIONAL TECHNOLOGY CORPORATION

Project No. 301159
June 1988



# Field Investigation Work Plan

Phase I Site Investigation and Analysis
Basin F Ground Water Treatment
Interim Response Action
Contract No. DACW45-88-D-0008

Rocky Mountain Arsenal
Commerce City, Colorado



Prepared for:

*Department of the Army*
*Corps of Engineers, Omaha District*
*Omaha, Nebraska*



RESPONSIVE TO THE NEEDS OF ENVIRONMENTAL MANAGEMENT

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THE PURPOSE OF THE FIELD INVESTIGATION AND ANALYSIS IS TO PERFORM A GROUND WATER INVESTIGATION INCLUDING:

1. INSTALLATION OF SIX MONITORING WELLS
2. WELL DEVELOPMENT
3. AQUIFER PERMEABILITY TESTING
4. GROUND WATER SAMPLING AND ANALYSIS.

SECTIONS OF THIS PLAN DETAIL INFORMATION ON:

1. GENERAL REQUIREMENTS - UTILITY CLEARANCES, SITE RESTORATION, SURVEYING
2. DRILLING PROCEDURES
3. SAMPLING PROCEDURES
4. WELL COMPLETION
5. PROJECT SCHEDULE
6. PERSONNEL RESPONSIBILITIES.

**14. SUBJECT TERMS**
EQUIPMENT, SAMPLING, DRILLING

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# FIELD INVESTIGATION WORK PLAN
# PHASE I SITE INVESTIGATION AND ANALYSIS
# BASIN F GROUND WATER TREATMENT INTERIM RESPONSE ACTION AT
# ROCKY MOUNTAIN ARSENAL
# COMMERCE CITY, COLORADO



Prepared for:

Department of the Army
Corps of Engineers, Omaha District
Contract Number DACW45-88-D-0008

Prepared by:

IT Corporation

Project Number 301159.01.01

Prepared by _____ Date: 6/28/88
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Approved by _____ Date: _____
U.S. Army Corps of Engineers

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# 1.0 INTRODUCTION

The purpose of the field investigation and analysis is to perform a ground water investigation including the installation of monitor wells, well development, aquifer permeability testing, and ground water sampling and analyses. These activities will be performed by IT Corporation and its subcontractors. The ground water sampling and part of the analyses will be performed by the RMA Technical Operations Division. The scope of work for the project includes drilling and installing six monitor wells for a hydrogeologic evaluation. Total drilling footage for the project is expected to be 330 lineal feet. The actual monitor well locations are shown in Figure 1.

# 2.0 GENERAL REQUIREMENTS

## 2.1 UTILITY CLEARANCES

Monitor well boreholes will be located by project personnel by chaining from established geographic and cultural features. Prior to startup of any drilling activities, Russ Wiggs (COE-Construction Representative at Basin F) will be contacted to provide locations of buried utilities in the vicinity of the marked boreholes. Where required, the boreholes will be relocated by offsetting them from the original staked location so as to provide a minimum safe clearance between the borehole and any marked utility location.

## 2.2 WATER SOURCE

Potable water is required for the drilling, decontamination, well development, and associated field activities. The source of water for the field activities will be the organic free dechlorinated supply at Building 728, as directed and approved by the Program Manager-Rocky Mountain Arsenal (PM-RMA). It is assumed the water will be available in sufficient quantity to satisfy the needs of the program.

## 2.3 DISPOSAL OF DRILL CUTTINGS

Drill cuttings created during monitor well drilling will be handled according to their contaminated or uncontaminated condition, based on screening described in the contract document and in the EPA procedure dated June 12, 1985, titled "EPA Region VIII Procedure for Handling of Materials from

Drilling, Trench Excavation, and Decontamination during CERCLA RI/FS Operations at the Rocky Mountain Arsenal." Details for handling wastes are presented in Section 6.0 of the General Work Plan.

## 2.4 SITE RESTORATION

The six monitor well sites will be restored to their near-original condition before demobilization is complete. The sites will be restored and debris removed to the satisfaction of the Army Facility Engineer. A final site tour/inspection will be conducted prior to demobilization. All equipment and supplies introduced by the drilling and well installation will be removed except for the disposed cuttings, monitor well stand pipe, and concrete apron.

## 2.5 SURVEYING OF WELL LOCATIONS

Well locations will initially be located by chaining from known cultural features or existing wells near the site. After completion, the coordinates for the wells will be determined to an accuracy of at least one foot in the State Plane Coordinate System. Ground elevations and top of the internal well casing elevations will be measured to the nearest 0.01 foot and referenced to the National Geodetic Vertical Datum of 1929 for the area.

The horizontal and vertical control for the surveying will be tied to benchmarks designated by the U.S. Army Corps of Engineers (COE). These benchmarks and their respective coordinates and elevations are as follows:

| DESCRIPTION | NORTHING, ft. | EASTING, ft. | ELEVATION, ft. msl |
|---|---|---|---|
| Brass cap in concrete monument, S.E. corner 9th Ave. and D Street | 191,089 | 2,183,604 | 5,188.65 |
| Brass cap in concrete at boring RMA 87-2 approximately 400 feet south of site | 190,791.95 | 2,181,454.48 | 5,185.91 |

Two permanent control monuments will be placed in accessible locations within the limits of the drilling if the existing monuments are greater than 1,000 feet from the site. The added monuments, should they be required, will be at a distance greater than 500 feet from each other and will have coordinates and

elevations established to the closest 1.0 and 0.01 feet respectively. Wells and monuments will be plotted on final figures at a scale sufficient to show their relation to other structures.

### 2.6 PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment should be compatible with and provide protection against the conditions anticipated at the site. Monitor-well drilling will be conducted under both contaminated and uncontaminated conditions and is expected to require Level C and Level D protection, respectively. Level D will include cotton clothing or Tyvek, steel-toed boots, safety glasses, hearing protection, and hard hat; optional equipment includes gloves, outer boots, and face shield. Level C will include an air purifying respirator with appropriate filter cartridges, chemical resistant clothing (gloves, Tyvek, boots) hearing protection, and hard hat; optional equipment includes boot covers and face shield. Air purifying respirators will be equipped for organic vapors with high efficiency particulate filters. Routine monitoring will be performed using Draeger tubes and/or an PID, as discussed in Section 3.3. For a detailed discussion of the personal protective equipment refer to the Safety, Health, and Emergency Response Plan sections of these work plans.

## 3.0 DRILLING

Subsurface drilling will be conducted at the six monitor well locations using the hollow-stem, continuous-flight augering method. The wells will be reamed to a larger final diameter to facilitate well installation. The methods and procedures are discussed in the following sections.

### 3.1 DRILLING METHOD

The hollow stem continuous flight augering method will be used to advance each boring to the estimated total depth of 55 feet for a total linear footage of approximately 330 feet for the six wells. The hollow-stem augers will be advanced into bedrock one to two feet. Footage after the fifth well will be assessed by the COE-PM, and a decision made by the COE-PM as to whether to drill and complete the sixth well. The initial drilling and sampling of the monitor well will be accomplished with a $3\frac{1}{2}$-inch I.D., hollow-stem auger and a

continuous core sampler. If the continuous core sampler does not work well in the materials encountered, split spoon sampling will be used as an alternate method. After completion of the sampling and total depth is reached, the borehole will be reamed with a larger diameter auger ($8\frac{1}{4}$ inches I.D.) to facilitate installation of the monitoring well.

Borings unable to advance through cobbles and boulders will be interpreted as refusal and drilling will continue with the next location. Offsetting and redrilling or changing the drilling technique will require contract amendment. Information will be provided as to the nature of refusal.

## 3.2 DRILLING LOGS

A detailed soil boring log will be maintained by the site geologist. An example of the boring log to be used on the project is provided as Figure 2. The log will serve as a record of sample collection, sample location and depth, and drilling procedure. It will include:

- Heading information such as the project number, boring designation, personnel involved, elevations and coordinates, start and completion dates, and well diameter
- Reference elevation
- Depths recorded to tenths of a foot for stratum changes, sampled intervals, ground water first contact and total hole depths
- Ground water information
- Detailed geotechnical soil descriptions including USCS descriptors, texture, moisture content, etc.
- Sampler type, penetration, and recovery
- Equipment details, such as drill rig type and type of auger
- Drilling details and comments.
- Depth at which screening techniques indicate contamination. PID readings will be included.

## 3.3 CONTAMINANT MONITORING

Contaminants will be monitored as discussed in Section 2.3, addressing the disposal of drill cuttings. The cuttings will be visually inspected for contamination and an instrument survey screening will be performed. A portable

PID will be used on five-foot intervals or less to check for volatile organic vapors. The PID screening will be performed throughout the sampled section.

### 3.4 DECONTAMINATION PROCEDURES

The drill rig, drilling tools, and associated sampling equipment will be cleaned prior to arrival at the RMA site (so they will be free of soil or mud) and steam cleaned at RMA prior to the commencement of drilling. Decontamination of drilling augers and sampling tools will be conducted between monitor wells. The drill rig and the drilling and sampling tools will be thoroughly cleaned prior to departure from the site. All decontamination steam cleaning will be performed at the RMA decontamination facility located in Section 36.

## 4.0 SAMPLING

The "Moss" continuous sampling system proposed for the field program sampling operates much like conventional rotary coring equipment. The sampler typically consists of a five-foot long, three-inch inner diameter, split barrel with a cutting shoe on the bottom end and a swivel attachment on the upper end. The swivel locks into the lead auger so that the split barrel advances with the auger bit but does not rotate. The barrel is retrieved by wire line so that the augers are not removed in between sample runs. The swivel is adjustable to allow the barrel and cutting shoe to be moved slightly ahead or behind the cutting teeth of the auger to improve sample recovery in soft or stiffer soils. A core catcher may also be used in the cutting shoe to improve sample recovery in noncohesive soils. A continuous sample of the soil is obtained for logging after which representative samples will be retained and stored in jars.

## 5.0 MONITOR WELL COMPLETION

The monitor well will be completed according to the typical well completion diagram provided in Figure 3. Well construction will be accomplished through the center of the $8\frac{1}{4}$" I.D. hollow stem auger used to ream the borehole to the larger diameter. Well screens and casing will be installed through the auger center, and sand packs and seals will be placed in the annulus around the well

piping and auger casing. As the sand pack and seals are placed, the auger flight will be raised so that the auger tip is just slightly above the top of the placed material as determined by sounding. This will prevent materials from plugging the auger and trapping the well screen or riser pipe. Once monitoring well installation begins, it will continue uninterrupted until the bentonite seal is placed. Well construction logs will be maintained by the field geologist/engineer. The following sections present the well design, development, and permeability measurements to be conducted.

## 5.1 WELL DESIGN

Monitor wells will be constructed of four-inch Schedule 40, flush jointed, threaded PVC piping and Johnson type well screen with a 0.020-inch slot width. The bottom of the screen will be fitted with a threaded PVC cap within six inches of the screen. The well screen will extend throughout the saturated zone and be situated such that approximately five feet will be above the water table. Well screen lengths will vary depending on site specific conditions. Well materials will be free of all foreign matter and PVC materials will be steam cleaned prior to installation. No solvent cements will be used in completing connections. Centralization of the casing in the well will be accomplished by installing the PVC screen and riser pipe through the augers.

The annular space between the PVC piping and the borehole surface will be backfilled with a sand filter pack. A small sample of the filter material will be provided to the PM-RMA Technical Operations Division (TOD) for approval prior to use on the site and a manufacturer's gradation curve will be supplied to the PM-COE, if available. The material used will be equivalent to a No. 8 to 12 mesh, washed silica sand. One to two feet of the sand filter shall be placed at a time and the auger flights retrieved at a corresponding distance to expose the sand to the formation outside the auger tip for each lift placed. The sand filter will be extended five feet above the top of the well screen. Organic free dechlorinated water used to facilitate well construction will be recorded and this volume later removed during well development.

A bentonite seal five feet thick will be placed above the sand filter where ground water conditions allow. The seal thickness will be measured at placement prior to swelling. The bentonite will be placed in the form of 1/4-inch diameter pellets. Hydration of the bentonite seal will be initiated using organic free, dechlorinated water before continuing with the grout seal.

The remainder of the annulus from the bentonite seal to the ground surface will be backfilled with a mixture of Portland cement (ASTM C 150), bentonite, and water. The water to cement volume ratio shall not exceed 1:1 (approximately 7 to 8 gallons of water to a 94-pound bag of cement). The cement to bentonite ratio will be approximately 20:1 by weight. The grout slurry may be placed by gravity flow or tremie pipe to the bottom of the interval to be grouted. The grout will be pumped to within three feet of the surface. The final sealing of the well to the surface will be accomplished with concrete as part of the protective casing installation and pad construction. Any excess grout shall be disposed of by the drilling contractor.

The monitor well will be checked for alignment once after the well casing is installed, prior to placement of the sand filter pack, and again at the completion of the installation by running a five-foot length pipe 3-3/4 inches in diameter the length of the PVC casing. The test will be performed to verify the alignment of the well. The results of the test will be documented in the daily reports.

Precautions shall be employed during all stages of construction and development to prevent tampering with the well and introduction of foreign material into the well. Well head protection shall consist of a vented cap on the PVC riser. The riser will be surrounded by an eight-inch diameter, five-foot long steel protective rising casing, two feet above the ground surface and set in concrete to three feet below the surface. The steel casing will have a locking protective cap as shown in Figure 3. A concrete apron constructed at the ground surface will be six inches thick, four feet in diameter, and sloped away from the well. Three 2-inch diameter or larger steel barrier posts will be equally spaced around the well and embedded in the concrete pad. The well riser will be painted white and labeled with identification numbers painted black.

In the event a well is deemed unacceptable by the PM-RMA TOD or COE, PM, the well will be abandoned. Wells must be deemed unacceptable prior to demobilization of the drill rig. At the direction of the COE, PM to abandon a well, it will be sealed by grouting from the bottom of the well screen to the ground surface using a tremie pipe. Grout will be pumped through the tremie pipe until undiluted grout flows at the casing surface.

## 5.2 WELL DEVELOPMENT

Well development will commence within two weeks of installation, but no sooner than 48 hours after grout seals have been placed. The development shall consist of mechanically surging the well and alternately bailing for a minimum of two hours or until all sediment is removed as evidenced by clear bailed water. At least five well volumes in addition to water added during construction will be removed from the well by bailing or pumping, as is appropriate.

During development activities, temperature, pH, and specific conductivity will be monitored. The monitoring will be performed for every well volume removed or sooner with any visible change in appearance. The COE Project Manager will be contacted for further direction if these parameters have not stabilized to less than a ten percent change between four consecutive readings. These parameters will be recorded on the "Well Development Data" form shown in Figure 4. If the addition of water is required to facilitate surging, only formation water from that well will be used. If a hydraulic conductivity in the formation precludes this, then bailing will be conducted until clear bailed water is recovered. Water removed during the development operation will be collected at the well site in suitable drums and handled in accordance with Section 6.0 of the General Work Plan.

After development of the well, approximately one liter of formation water will be collected in a decontaminated, clean, clear glass jar which will be properly labeled, and photographed with 35 mm slide film to be included as part of the well construction log. The nephelometric turbidity shall be determined in accordance with ASTM D 1889, "Turbidity of Water."

Equipment used in the wells during development will be decontaminated between wells. The decontamination will consist of the following steps:

- Wash with TSP and water
- Rinse with organic-free dechlorinated water
- Rinse with methanol
- Rinse with organic-free dechlorinated water

## 5.3 PERMEABILITY MEASUREMENTS

In situ rising head tests (slug tests) will be performed to determine well sensitivity and hydraulic conductivity in the new monitor wells and possibly in existing well 23049. In the slug test a near instantaneous change in head in the column of water in the well is created and a record of the recovery data is obtained (water level and elapsed time) as the well returns to its original static level. The change in head will be accomplished by displacing a volume of water with a solid slug of inert materials. Water level recovery will be monitored with a pressure transducer in the well. The test will be performed according to the following:

- The well will be allowed to equilibrate after development before any slug testing is conducted. A stable water level will be determined. Inert slugs of appropriate size for the well will be emplaced and withdrawn with polypropylene rope. The rope will be sized to support the slug but have minimal effect on the water volume.

- The water level will be allowed to stabilize after insertion of the slug and then measured to 0.01 feet.

- A pressure transducer of an appropriate range that is accurate to 0.01 feet and capable of measuring head changes of 20 feet, will be used. It will be located such that it remains below the lower limit of the slug and beneath the water level. A digital data logger will record the information.

- Equipment will be decontaminated between wells (see Section 3.4). Polypropylene ropes will be used once per well and disposed of properly.

- Well data may be analyzed using the Bouwer and Rice method (1976) for unconfined aquifers or alternate methods. Semilogarithmic plots of residual head versus time are used to determine the hydraulic conductivity.

Details of sampling and analysis of ground water are presented in the Analytical Plan for Waters.

## 6.0 FIELD ACTIVITY RECORDS

The field activities will be recorded and documented using the following IT Corporation or government supplied forms:

- Field Activity Daily Log
- Borehole Summary Log
- Well Construction Summary
- Soil Collection Log
- Borehole/Well Abandonment Report
- Chain-of-Custody Forms
- Request for Analysis
- Variance Log.

Examples of these forms are provided in the appendix. Procedures for completing the Quality Control reports are specified in Section 4.0 of the Analytical Plan for Water.

## 7.0 SCHEDULE

The generalized schedule for the Field Investigation is presented in Figure 5. A monitor well will be the first boring drilled when field activities begin on July 5. The well shall be complete and a ground water sample suitable for analysis will be obtained within two weeks of this start date. The remainder of the monitoring wells will be scheduled in conjunction with the 14 foundation investigation borings to complete the field program by August 11. The data analysis will begin August 12 and a complete report submitted by October 7 barring unforeseen delays.

## 8.0 PERSONNEL RESPONSIBILITIES

Work on the monitor well task will be performed by personnel from IT Corporation, Ground Exploration, and Western States Surveying Company, as is specified in Section 9.0 of the Foundation Investigation Plan. IT will be responsible for the subsurface investigation and a portion of the sample analysis. Ground Exploration will provide drilling services and Western States Surveying will perform the final survey of well locations. The project organization is presented in Figure 6.

The following individuals will be involved in the project at various capacities.

## 8.1 FIELD MANAGER

The IT Field Manager will be on site to act as liaison between the Corps of Engineers, Rocky Mountain Arsenal Program Management, and IT Corporation. The Field Manager will ensure project scope is satisfied and activities are completed according to the Work Plans.

## 8.2 FIELD GEOLOGIST/ENGINEER

The IT Field Geologist/Engineer will be responsible for maintaining a detailed log of each boring, obtaining continuous samples, and supervising the installation and development of the wells. The field personnel will be present and keep accurate records of all drilling, sampling, installation, and development activities.

## 8.3 HYDROGEOLOGIST

The Hydrogeologist will be responsible for performing the permeability testing on the six monitoring wells to be installed. The hydrologist will compile the developed data and perform analyses to determine approximate hydraulic conductivity for the formations. The results will be presented in the final analysis report.

## 8.4 DRILL CREW

The Drilling Crew will be comprised of two or three personnel provided by Ground Exploration under direct subcontract to IT Corporation. The Crew will be responsible for all activities related to drilling, sampling of soil, and installing and developing the monitor wells. Activities will be performed under the supervision of the IT field representative.

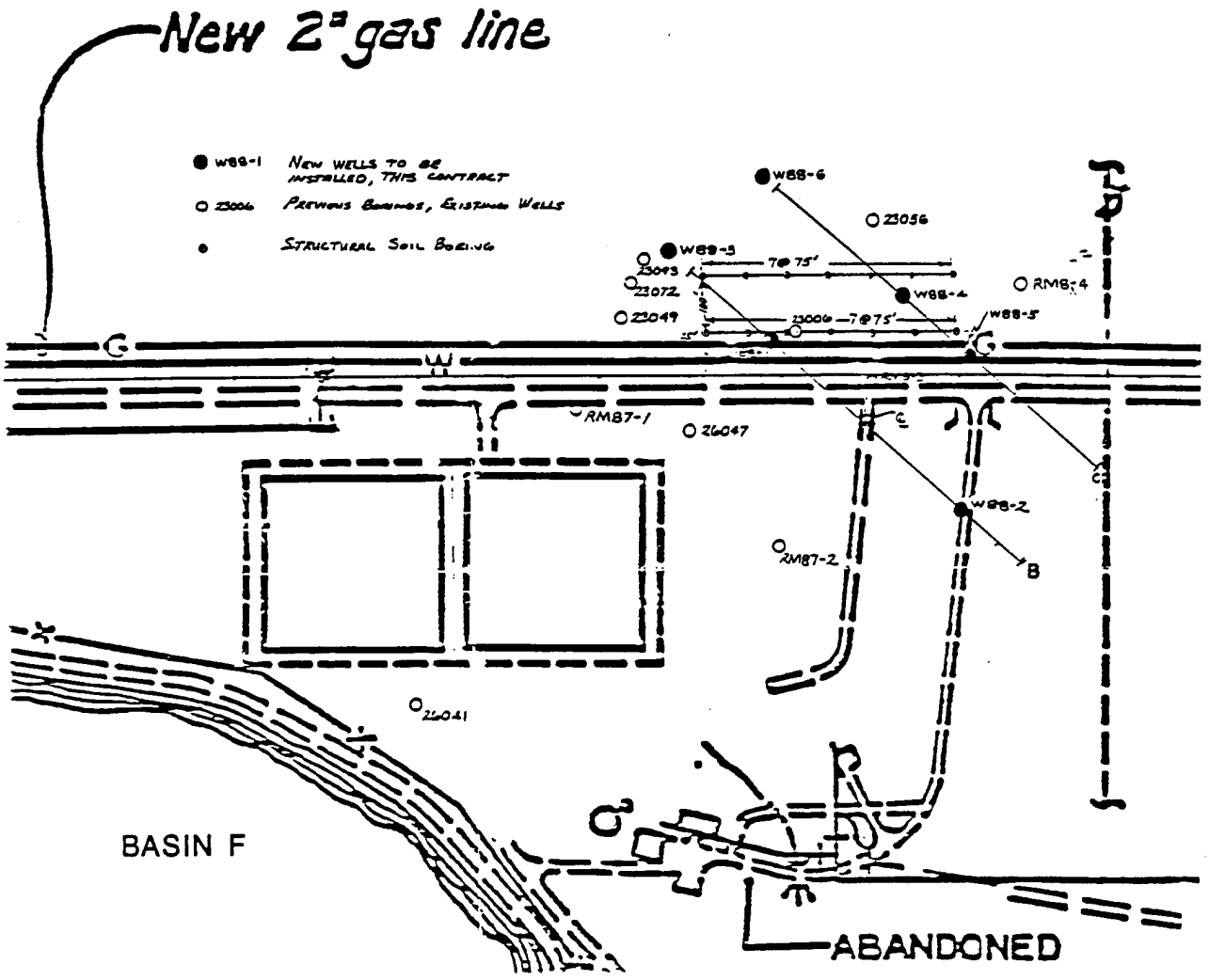
## 8.5 SURVEY CREW

The Survey Crew provided by Western States Survey Company will perform the final site survey of the well locations. The Survey Crew will also install the permanent control monuments near the site, should they be required.

TABLE 1

PROJECT SCHEDULE
PHASE 1 SITE INVESTIGATION AND ANALYSIS
BASIN F GROUND WATER TREATMENT
INTERIM RESPONSE ACTION

| ACTIVITY | DATES |
|---|---|
| Notice to Proceed | May 17, 1988 |
| Preparation of Draft Work Plans | May 18 - June 13 |
| COE Review of Draft Work Plans | June 14 - June 20 |
| Review Meeting b/w COE and IT | June 16 |
| IT Revises/Finalizes Work Plans | June 21 - June 29 |
| UXO Sweep | Week of June 20 |
| Mobilize for Drilling | June 29 and 30 |
| Site Specific Safety Training Meeting | July 5 |
| Field Investigation | July 5 - August 11 |
| First Ground Water Samples Obtained | Approx. July 12 - July 15 |
| Laboratory, Analysis and Report Preparation | August 12 - October 7 |
| (Draft Report - September 15) | |
| (COE Comments - September 30) | |
| (Final Report - October 7) | |




SOURCE: US ARMY COE, JUNE 6 1988.

SCALE

0 400 800 FEET

FIGURE 1

PROPOSED
BORING/MONITORING WELL LOCATIONS

PHASE I SITE INVESTIGATION AND ANALYSIS
BASIN F GROUND WATER TREATMENT
INTERIM RESPONSE ACTION

IT CORPORATION

# VISUAL CLASSIFICATION OF SOILS

| | | |
|---|---|---|
| PROJECT NUMBER: | PROJECT NAME: | |
| BORING NUMBER: | COORDINATES: | DATE: |
| ELEVATION: | GWL: Depth Date/Time | DATE STARTED: |
| ENGINEER/GEOLOGIST: | Depth Date/Time | DATE COMPLETED: |
| DRILLING METHODS: | | PAGE OF |

| DEPTH ( ) | SAMPLE TYPE & NO. | BLOWS ON SAMPLER PER ( ) | RECOVERY ( ) | DESCRIPTION | USCS SYMBOL | MEASURED CONSISTENCY (TSF) | REMARKS |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

*NOTES:*

FIGURE 2

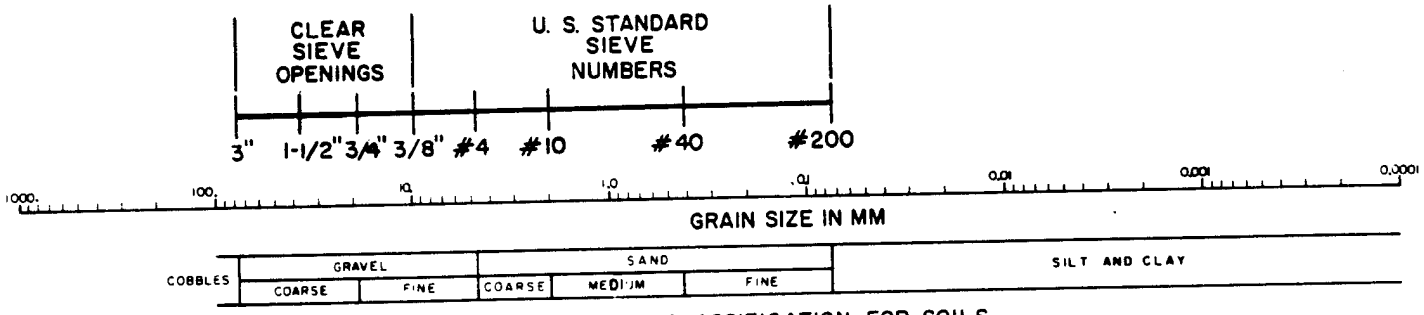
## CONSISTENCY OF COHESIVE SOILS

| CONSISTENCY | UNCONFINED COMPRESSIVE STRENGTH(TONS PER SQUARE FOOT) |
|---|---|
| VERY SOFT | LESS THAN 0.25 |
| SOFT | 0.25 TO 0.50 |
| MEDIUM STIFF | 0.50 TO 1.0 |
| STIFF | 1.0 TO 2.0 |
| VERY STIFF | 2.0 TO 4.0 |
| HARD | MORE THAN 4.0 |

## DENSITY OF GRANULAR SOILS

| DENSITY | STANDARD PENETRATION RESISTANCE(1) |
|---|---|
| VERY LOOSE | 0 – 4 |
| LOOSE | 5 – 10 |
| MEDIUM DENSE | 11 – 30 |
| DENSE | 31 – 50 |
| VERY DENSE | OVER 50 |

(1) **STANDARD PENETRATION RESISTANCE IS THE NUMBER OF BLOWS REQUIRED TO DRIVE A 2-INCH O.D. SPLIT BARREL SAMPLER 12 INCHES USING A 140-POUND HAMMER FALLING FREELY THROUGH 30 INCHES. THE SAMPLER IS DRIVEN 18 INCHES AND THE NUMBER OF BLOWS RECORDED FOR EACH 6-INCH INTERVAL. THE SUMMATION OF THE FINAL TWO INTERVALS IS THE STANDARD PENETRATION RESISTANCE.**




USCS CLASSIFICATION FOR SOILS

## COARSE-GRAINED SOILS

| | | |
|---|---|---|
| CLEAN GRAVELS (LITTLE OR NO FINES) | GW | WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES |
| | GP | POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES |
| GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES) | GM | SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES |
| | GC | CLAYEY GRAVELS GRAVEL-SAND-CLAY MIXTURES |
| CLEAN SANDS (LITTLE OR NO FINES) | SW | WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES |
| | SP | POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES |
| SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES) | SM | SILTY SANDS, SAND-SILT MIXTURES |
| | SC | CLAYEY SANDS, SAND-CLAY MIXTURES |

## FINE-GRAINED/HIGHLY ORGANIC SOILS

| | | |
|---|---|---|
| SILTS AND CLAYS LIQUID LIMIT (LESS THAN 50) | ML | INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY |
| | CL | INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS |
| | OL | ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY |
| SILTS AND CLAYS LIQUID LIMIT (GREATER THAN 50) | MH | INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS |
| | CH | INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS |
| | OH | ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS |
| HIGHLY ORGANIC SOILS | PT | PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS |

FIGURE 2 con't.

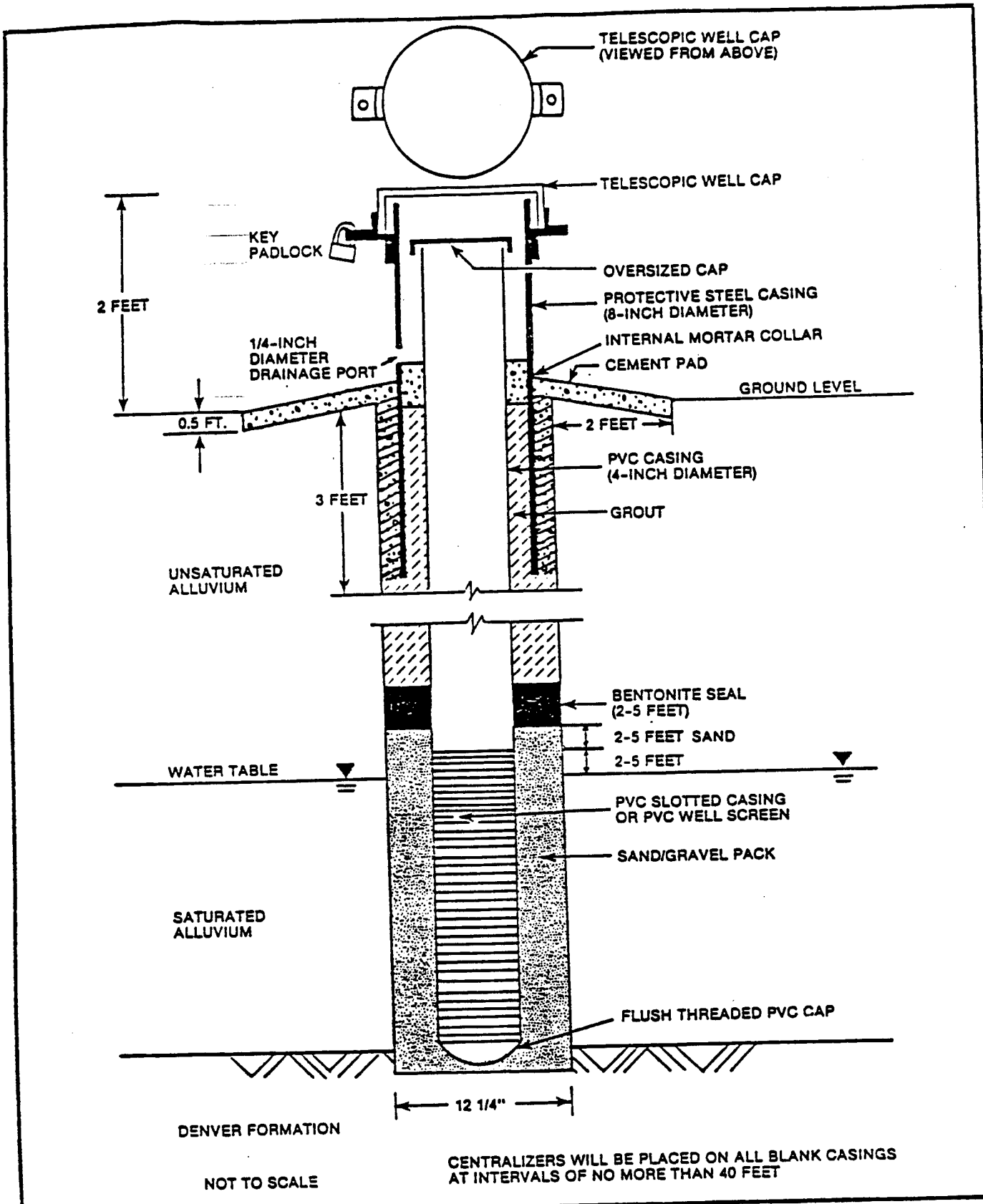



Figure
GENERALIZED AQUIFER MONITOR
WELL CONSTRUCTION

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

FIGURE 3

IT

# WELL DEVELOPMENT RECORD

WELL _____

PROJECT NAME: _____

PROJECT NUMBER: _____

LOCATION: _____

WELL DEPTH = _____ FEET

REFERENCE POINT FOR
DEPTH MEASUREMENTS _____
TPC = TOP OF PROTECTIVE COVER
TWC = TOP OF WELL CASING
GS = GROUND SURFACE

| DEVELOPER'S INITIALS | DATE | INITIAL WATER DEPTH (FEET) | SURGING EQUIPMENT/ METHOD | EVACUATION | | | FINAL WATER LEVEL (FOR RECOVERY RATE) | | WATER VISUAL APPEARANCE | COMMENTS (ODOR, CHEMICALS USED, NAPL, ETC.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | STARTING TIME | METHOD | TOTAL VOLUME REMOVED (GALLONS) | DEPTH (FEET) | TIME | | |
| | | | | | | | | | | |
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B = BAILER
SP = SUBMERSIBLE PUMP

CLEAN
SLIGHTLY CLOUDY
CLOUDY
MUDDY

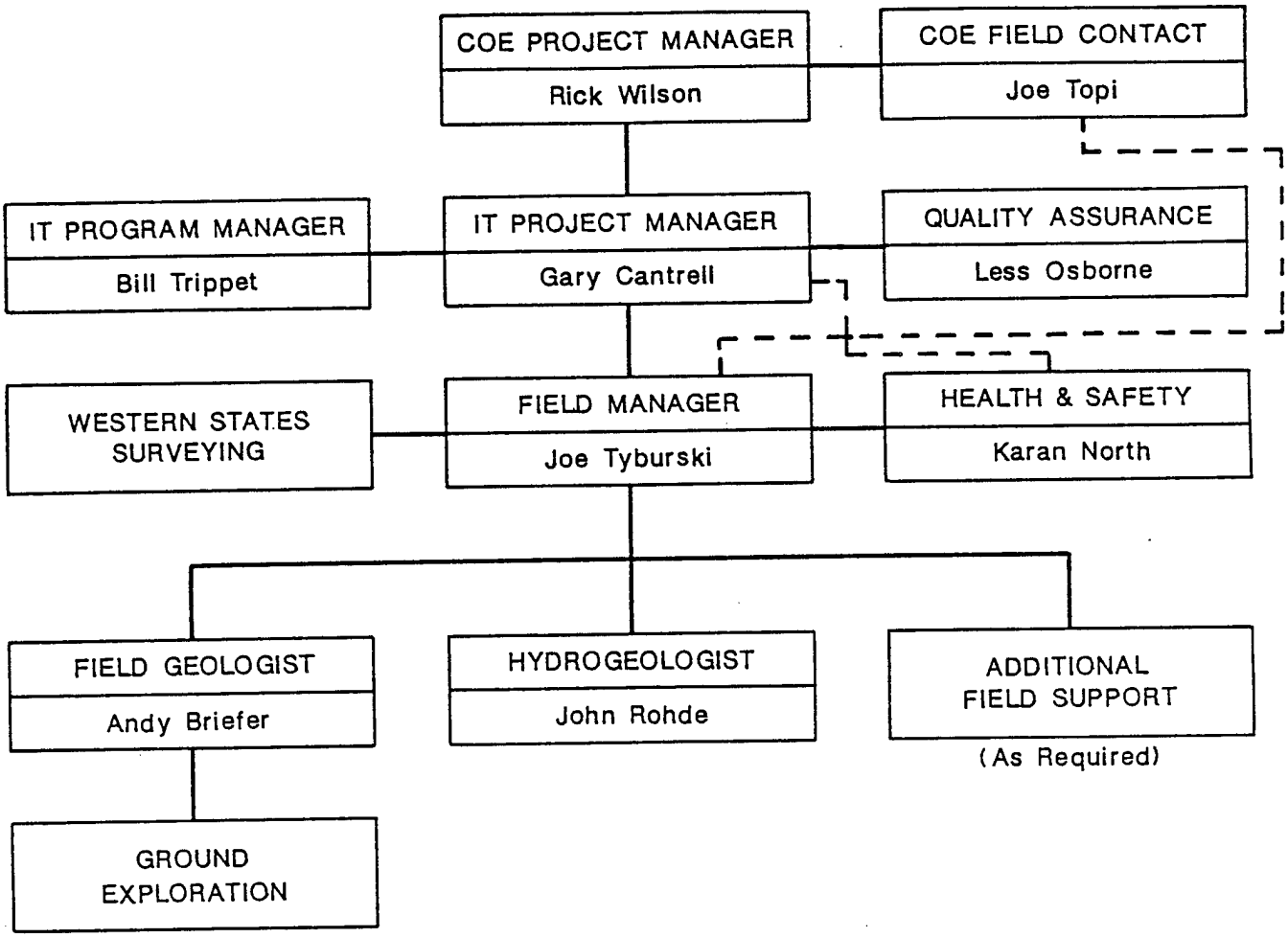


FIGURE 5

PROJECT ORGANIZATION

PHASE I SITE INVESTIGATION AND ANALYSIS
BASIN F GROUND WATER TREATMENT
INTERIM RESPONSE ACTION

# APPENDIX A

FORMS

IT CORPORATION

# FIELD ACTIVITY DAILY LOG

| DAILY LOG | | | | |
|---|---|---|---|---|
| | DATE | | | |
| | NO. | | | |
| | SHEET | | OF | |

| PROJECT NAME | PROJECT NO. |
|---|---|
| FIELD ACTIVITY SUBJECT: | |
| DESCRIPTION ON DAILY ACTIVITIES AND EVENTS: | |
| VISITORS ON SITE: | CHANGES FROM PLANS AND SPECIFICATIONS, AND OTHER SPECIAL ORDERS AND IMPORTANT DECISIONS. |
| WEATHER CONDITIONS: | IMPORTANT TELEPHONE CALLS: |
| IT PERSONNEL ON SITE: | |
| | (FIELD ENGINEER) DATE |

PAGE_____OF_____

## BOREHOLE SUMMARY LOG

Borehole _____ Well _____

Project Name and Location _____ Project Number _____

Drilling Company _____ Driller _____ Rig Number _____

Drilling Method(s) _____

_____

Size(s) and type(s) of bit(s) _____

Borehole Diameter _____in. _____cm. _____ft. _____cm. to _____ft. _____cm.

_____in. _____cm. _____ft. _____cm. to _____ft. _____cm.

Sampling Methods _____

Total Number Soil Sampling Tubes _____

Total Number Core Boxes _____

Number of Gallons Lost Drilling Fluid _____

Date/Time Started Drilling _____

Date/Time Completed Drilling _____

Total Borehold Depth _____ft. _____cm.

Depth to Bedrock _____ft. _____cm.

Depth to Water _____ft. _____cm.

Water Level Determined By? _____

Borehole Completed as Monitoring Well? _____

Date/Time Grouting Completed _____

Depth of Tremmie Pipe _____

Gallons of Grout _____

Materials Used _____

Comments _____

_____

_____

Wellsite Geologist _____ Date _____

Checked for Grout Settlement on _____ by _____

Amount of Grout Added _____

All Measurements from Ground Level

Reviewed by _____ Date _____

Drill Site Geologist _____ Date _____

Figure
BOREHOLE SUMMARY LOG

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

# WELL CONSTRUCTION SUMMARY

PROJECT NAME: _____

PROJECT NUMBER: _____ DATE: _____ WELL: _____

LOCATION: _____

ELEVATION (GROUND): _____ GEOLOGIST _____

DEPTH (Ft.) | AS-BUILT DIAGRAM | LITHOLOGY

0

## DRILLING SUMMARY

TOTAL DEPTH _____

HOLE DIAM. _____

DRILLER _____

RIG _____

BIT(S) _____

FLUID _____

CASING _____

## WELL DATA

CASING: C = CASING S = SCREEN

CASING: C1 _____

C2 _____

SCREEN: S1 _____

S2 _____

FILTER PACK: _____

DEPTH: ____ - ____

BENTONITE: _____

DEPTH: ____ - ____

CEMENT: _____

DEPTH: ____ - ____

APPROX. PROTECTIVE COVER STICKUP: _____

OTHER: _____

## CONSTRUCTION TIME LOG

| TASK | START DATE | START TIME | END DATE | END TIME |
|---|---|---|---|---|
| DRILLING: | | | | |
| | | | | |
| | | | | |
| | | | | |
| GEOPHYS. LOG: | | | | |
| CASING: | | | | |
| | | | | |
| | | | | |
| | | | | |
| FILTER PACK: | | | | |
| CEMENT: | | | | |
| DEVELOPMENT: | | | | |
| OTHER: | | | | |
| | | | | |
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## WELL DEVELOPMENT

## REMARKS

STATIC WATER LEVEL _____

INTERNATIONAL TECHNOLOGY CORPORATION

REVISED 7/7/87

INTERNATIONAL TECHNOLOGY CORPORATION

| | | | | | | |
|---|---|---|---|---|---|---|
| DATE | | | | | | |
| TIME | | | | | | |
| PAGE ____ OF ____ | | | | | | |
| PAGE | | | | | | |
| PROJECT NO. | | | | | | |

# SAMPLE COLLECTION LOG

PROJECT NAME _____

SAMPLE NO. _____

SAMPLE LOCATION _____

SAMPLE TYPE _____

COMPOSITE _____YES _____NO

COMPOSITE TYPE _____

DEPTH OF SAMPLE _____

WEATHER _____

| CONTAINERS USED | AMOUNT COLLECTED |
|---|---|
| | |
| | |
| | |
| | |

COMMENTS:

PREPARED BY: _____

BOREHOLE

SHEET _____ OF _____

# BOREHOLE OR WELL ABANDONMENT REPORT

BORING NUMBER: _____ DATE _____

PROJECT NUMBER: _____ TASK NUMBER: _____

PROJECT DESCRIPTION: _____

BEGAN DRILLING: _____ ENDED DRILLING: _____

| | DEPTHS | DATES MEASURED |
|---|---|---|
| Total Depth: | | |
| Sampled to: | | |
| To Water: | | |
| To Mud: | | |
| Caved Hole: | _____ to _____ | |
| | _____ to _____ | |

ITEMS LEFT IN THE HOLE

Description: _____ Depth: _____

GROUT BACKFILL

Initial Quantity: _____ Date: _____

Quantity Added: _____ Date: _____

_____ Date: _____

REASON FOR ABANDONMENT: _____

Figure
BOREHOLE OR WELL ABANDONMENT REPORT

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

INTERNATIONAL TECHNOLOGY CORPORATION

# CHAIN-OF-CUSTODY RECORD

R/A Control No. _____

C/C Control No. 58734

PROJECT NAME/NUMBER _____ LAB DESTINATION _____

SAMPLE TEAM MEMBERS _____ CARRIER/WAYBILL NO. _____

| Sample Number | Sample Location and Description | Date and Time Collected | Sample Type | Container Type | Condition on Receipt (Name and Date) | Disposal Record No. |
|---|---|---|---|---|---|---|
| | | | | | | |
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| | | | | | | |

Special Instructions: _____

Possible Sample Hazards: _____

SIGNATURES: (Name, Company, Date and Time)

1. Relinquished By: _____

   Received By: _____

2. Relinquished By: _____

   Received By: _____

3. Relinquished By: _____

   Received by: _____

4. Relinquished By: _____

   Received By: _____

WHITE - To accompany samples
YELLOW - Field copy

INTERNATIONAL TECHNOLOGY CORPORATION

# REQUEST FOR ANALYSIS

R/A Control No. 625

C/C Control No. _____

PROJECT NAME _____

PROJECT NUMBER _____

PROJECT MANAGER _____

BILL TO _____

_____

_____

PURCHASE ORDER NO. _____

DATE SAMPLES SHIPPED _____

LAB DESTINATION _____

LABORATORY CONTACT _____

SEND LAB REPORT TO _____

_____

_____

DATE REPORT REQUIRED _____

PROJECT CONTACT _____

PROJECT CONTACT PHONE NO. _____

| Sample No. | Sample Type | Sample Volume | Preservative | Requested Testing Program | Special Instructions |
|---|---|---|---|---|---|
| | | | | | |
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TURNAROUND TIME REQUIRED: (Rush must be approved by the Project Manager.)

**Normal** _____ **Rush** _____ (Subject to rush surcharge)

POSSIBLE HAZARD IDENTIFICATION: (Please indicate if sample(s) are hazardous materials and/or suspected to contain high levels of hazardous substances)

**Nonhazard** _____ **Flammable** _____ **Skin Irritant** _____ **Highly Toxic** _____ **Other** _____ **(Please Specify)**

SAMPLE DISPOSAL: (Please indicate disposition of sample following analysis. Lab will charge for packing, shipping, and disposal.)

**Return to Client** _____ **Disposal by Lab** _____

FOR LAB USE ONLY

**Received By** _____ **Date/Time** _____

WHITE - Original, to accompany samples
YELLOW - Field copy

INTERNATIONAL TECHNOLOGY CORPORATION

VARIANCE NO._____

# VARIANCE LOG

PROJECT NO._____ PAGE ___ OF ___

PROJECT NAME _____ DATE:_____

VARIANCE (INCLUDE JUSTIFICATION)

APPLICABLE DOCUMENT:

CC:

REQUESTED BY: _____ Date: _____

Approved By: _____ Date: _____
Project Manager

_____ Date: _____
Quality Assurance Officer

_____ Date: _____